2006-07
ANNUAL HABITAT WORK PLAN

PARKER RIVER NATIONAL WILDIFE REFUGE

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Parker River National Wildlife Refuge was established in 1942 primarily to provide feeding, resting and nesting habitat for migratory birds. The Refuge consists of 4,662 acres of diverse upland and wetland habitats including sandy beach, dune, Maritime shrubs and forests, salt marsh, man-made impoundments, and grassland habitats. These Refuge habitats support varied and abundant populations of resident and migratory wildlife species including more than 300 species of birds and additional species of mammals, reptiles, amphibians, insects and plants. The Refuge also supports nesting piping plovers, a federally listed threatened species.

Parker River also administers the Thacher Island National Wildlife Refuge, located off the coast of Rockport. Thacher Island historically supported a large tern colony, and has been managed in cooperation with the Town of Rockport and the Thacher Island Association since the late 1990s.

We recently completed a Habitat Management Plan for the two Refuges, which will guide the management of the wildlife and habitats on the Refuges for the next 15 years. The goals, objectives, and strategies from the HMP are incorporated into this Annual Habitat Work Plan and will guide management for 2007.

A. Piping Plover and Least Tern Management

Habitat Objective
Work cooperatively with State (Sandy Point State Reservation) and local towns (Newburyport and Newbury) to protect from disturbance and degradation nine miles of nesting, staging, and foraging habitat for piping plovers and least terns. Through seasonal closures, predator management, and public education, maintain a minimum productivity of 1.5 chicks over a five-year period for piping plovers and a nesting least tern colony of 50-100 pairs.

2006 Management Prescription
Starting April 1, the Refuge closed 6.2 miles of Refuge beach to public access during the plover nesting season to minimize human disturbance. Monitoring of plover nesting activity begin in late March and were conducted 2-3 times a week. Due to severe staff shortage in May, plover surveys were not conducted on Refuge and town beaches between May 4th and May 23th. Surveys resumed on May 27th and continued until September 1. Once again, we protected the tern colony with an electric fence; installed on June 19th, approximately 5 days after finding the first tern nest.

The area just off Lot #1 (from the foot of the stairway to the north boundary) remained open during the entire nesting period for public access. This area was symbolically fenced and signed. The southern portion of the Refuge beach (Lot 6 and 7) was opened to public use on July 13 after the failure of Nest #3 at mile marker 6.05. The entire beach was re-opened on September 1st.

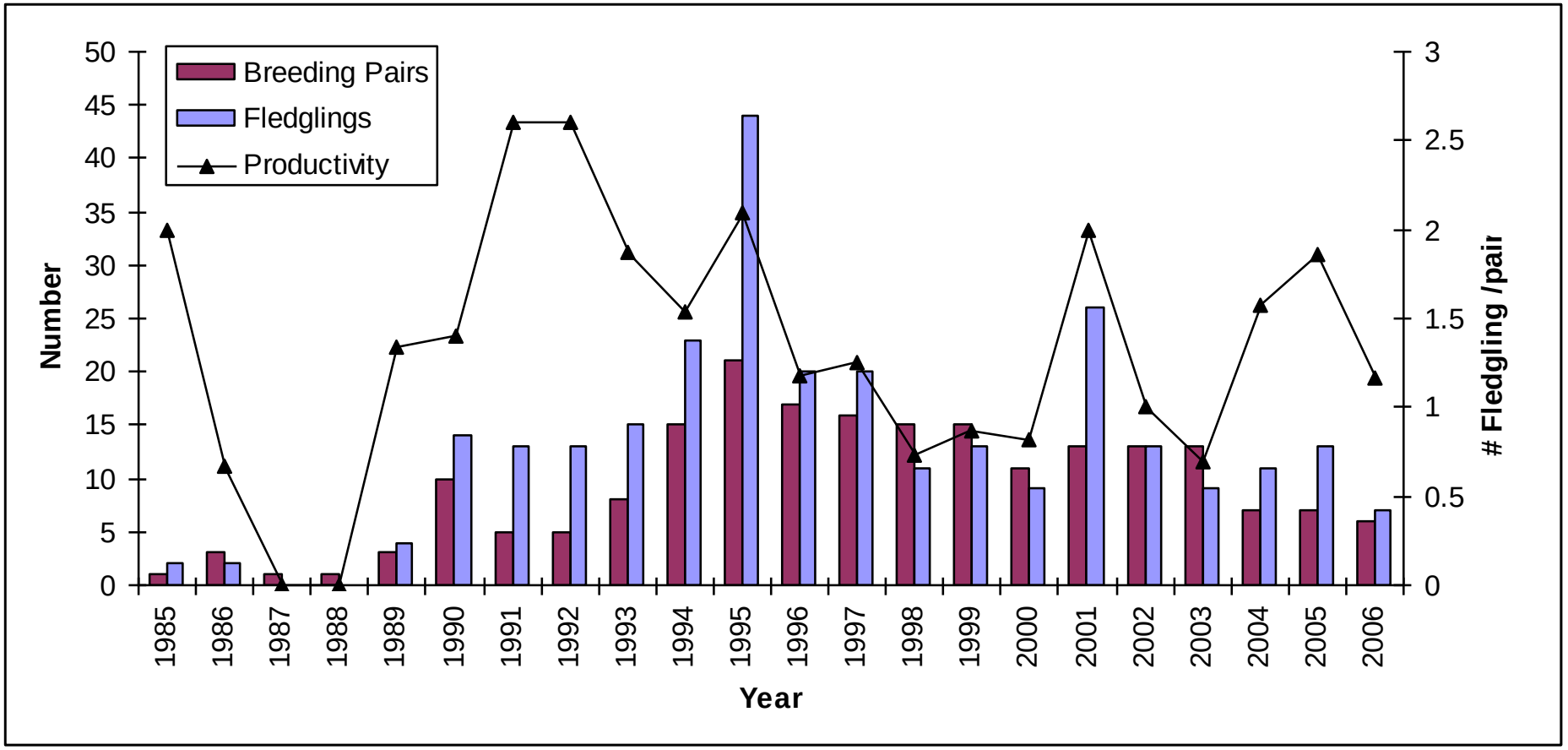

Figure 1. Breeding pairs of piping plovers and fledgling success at Parker River National Wildlife Refuge from 1985 to 2006. Productivity is calculated as number of fledged young per breeding pair. Plover productivity at Sandy Point and Town beaches are not included in the above figure.

Habitat Response
Not applicable.

Response of Resources of Concern
Thirteen pairs of piping plover (*Charadrius melodus*) and 30 pairs of least terns (*Sterna antillarum*) nested on Plum Island in 2006. The plovers produced 18 nests, 55 eggs, 25 chicks, and 12 fledglings. Hatching success was 45%; fledgling success was 48% and overall productivity was 0.92 fledglings per nesting pair. Six pairs (46%) successfully fledged young. The number of nesting plovers have steadily declined since 1995 (21 pair), while the productivity has fluctuated between 0.7 and 2.0 in the same period (Figure 1). The current 5-year average is 9.2 nesting pairs with productivity of 1.3. The best 5-year average (1994-1998) is 16.8 nesting pairs with productivity of 1.4.

Predation was the major cause of nest failure during the 2006 season, accounting for 75% of nest failures. Avian predation associated with the modified lobster traps was an issue at Crane Beach this year, and also resulted in the loss of one adult plover at Sandy Point State Reservation. Predation also accounted for 71% of nest failure at Sandy Point, and 100% of the nest failure at the town beach. Due to the reported adult predation at Crane Beach by an avian predator, we did not exclose most nests found after May, leading to high nest predation. We set up some predator traps where predator signs were noted on the beach in June, but only trapped one opossum.

There was significant predator activity at Sandy Point, resulting in very poor hatching rate, 30%. Most mammalian tracks at the eastern portion of Sandy Point were canine, while most of the tracks at the western portion were mustelid. At least one adult is believed to have been predated by an avian predator, probably a northern harrier. On the Refuge beach, there were less skunk and raccoon activity, but fox and coyote tracks were found on the beach; and a canine actively targeted an exlcosed nest at the south end, resulting in nest failure. One of the two nests at the town beach was predated by an unknown predator.

A least tern colony once again established between Lot 2 and 3. We estimated the number of breeding pairs to be between 20 and 30 (26 during the State-coordinated count). This is down from a count of 36 nesting pairs in 2005, and 160 nesting pairs in 2004. However, we did successfully fledge at least 26 young in 2006.

For a detailed report on the plover management program, see the 2006 Annual Plover Report.

Proposal Year: Management Strategy Prescriptions
- Close the Refuge beach beginning April 1, including beach access lots 2,3,5,6, and 7. Parking lots will remain closed while section of the beach still supports nesting activity for plovers and terns.
- Continue monitoring and limiting public use to nesting sites as outlined in the HMP.

- Increase survival and productivity of plover and tern adults and chicks through management of potential predators, including raccoons, skunks, red fox, grey fox, coyote, gulls, crows, night-herons and great horned owls.
  - Coordinate closely with staff from Cranes Beach on avian predator targeting plover adults at exclosed nests. Use the older circular exclosures for the 2007 field season. At first sign of adult predation, pull all exclosures to minimize adult loss.
  - Install an electric fence around tern nesting colony to protect colony from mammalian predators.
  - Working with State, Crane's Beach, and neighboring refuges, contract with USDA or other predator experts to conduct mammalian predator trapping prior to the start of the nesting season.

B. Maritime Shrubland and Forests

Habitat Objective
Manage 333 acres of maritime shrubland and forest to provide nesting and migratory stopover habitat for landbirds of conservation concern including eastern towhee, brown thrasher, prairie warbler, and to benefit the New England cottontail. Specific management objectives are:

1. Annually, maintain a minimum of 100 acres of maritime shrub and forest habitat with medium to high stem density (>10,000 stems/ha) to provide nesting and feeding habitat for eastern towhee, brown thrasher, and prairie warbler.

2. By 2021, increase native maritime shrub and forest communities (dominated by native fruit-bearing shrubs and trees, including shadbush, black cherry, arrowwood, beach plum, bayberry, and elderberry and comprising less than 5% invasive plants) to 50-100 acres to benefit fruit-eating migratory landbirds.

2006 Management Prescription

Monitoring and Surveys
Massachusetts Audubon has been running a spring and fall migratory banding station in the shrub habitat on the Refuge since 1998. We conducted the annual landbird breeding survey on June 4th and 6th, and a whip-poor-will survey on June 12th. In February of 2006, we searched for presence of New England cottontails on the Refuge by tracking rabbit signs and collecting pellet samples for mRNA analysis.

Herbivore Management
The annual deer hunt was held on December 3rd. Thirty hunters participated in the hunt and harvested three deer: one doe, one buck, and one fawn.

Invasive Plant Control
We are continuing to remove the invasive black locust and multiflora rose along the main Refuge road. In 2006, we treated a 3-mile stretch along the Refuge road; from northern boundary to Hellcat Parking Lot, and treated 7 stands of multiflora rose along the road.

Habitat Response

Invasive Plant Management

In 2004, we bulldozed a dozen autumn olives shrubs along the Refuge road. Follow-up monitoring did not detect re-sprouting of autumn olive at these sites; but small saplings have been noted along the roads. Second year monitoring for the multiflora and beach rose we sprayed in 2005 found the Rodeo/Escort mix to be a highly effective control method (100% control in Year 2; see Appendix A for before and after photos). Native plants are colonizing many of these areas; although dead woody stems of mature roses still dominate at some sites. Girdling of black locust continues to provide effective control of this species; however, we noticed regeneration of black locust in areas treated in 2004. Morrow's honeysuckle density also increased from 2005 to 2006.

Response of Resources of Concern

Monitoring and Surveys

In 2006, the Massachusetts Audubon banding station banded 1,848 birds from 70 species with a banding effort of 4,152 net hours. The most common species captured were gray catbird, yellow-rumped warbler, hermit thrush, and white-throated sparrow. Recapture data indicate that Parker River NWR is an important stopover area for migrating song birds, particularly during the fall migration. This is especially true for young birds (hatched the same year), as they make up roughly 90 percent of all birds banded during the fall migration.

Table 1. Number and species of birds banded at the Massachusetts Audubon banding station at Parker River Refuge from 2001 to 2006.

Year	Spring			Fall			Total	
	# sp	# bird	catch per effort	#sp	# bird	catch per effort[1]	# sp	# bird
2006	45	452	20.62	62	1396	33.63	70	1848
2005	48	930	42.31	66	1758	58.1	72	2359
2004	69	1361	51.00	66	2092	38.88	87	3453
2003	62	698	36 days*	45	881	39 days*	76	1579
2002	69	1473	63.8	57	1176	41.5	82	2649
2001	62	893	44.25	62	1484	59.67	76	2377

*net hours were not available in 2003 to calculate catch per effort

We detected 73 species and 1,418 individual birds during the 2006 breeding bird survey. The most common species detect were red-winged blackbird, willets, tree swallow, yellow warbler, common yellowthroat, gray catbird, eastern towhee, bobolink, and salt marsh sharp-tailed sparrow. Table 2 summarizes the relative abundance of the common species in 2006 compared to the average of all survey years.

On the whip-poor will survey, we detected 4 or more[2] whip-poor-wills during a single count along the Refuge road.

[1] Catch per effort is calculated as the total number of birds caught per 100 net hours. For 2003, catch per effort was not calculated as survey effort was recorded in days instead of net hours

[2] A total of six whip-poor-wills were detected, but two may be double counts.

Table 2. Relative abundance of common species detected during breeding bird survey at Parker River NWR.

Species	2006		1994 – 2006 Average		Relative Abundance
	Freq	Avg # / Pt	Freq	Avg # / Point	
Cedar Waxwing	0.22	1.14	0.49	0.8	H
Willet	0.46	1.17	0.82	0.78	H
Saltmarsh Sharp-tailed Sparrow	0.31	1.78	0.38	0.74	H
Common Yellowthroat	0.38	1.62	0.49	0.59	H
Mourning Dove	0.28	0.89	0.53	0.55	H
Eastern Kingbird	0.31	0.77	0.65	0.54	H
American Goldfinch	0.28	0.8	0.57	0.54	H
American Robin	0.26	0.88	0.53	0.5	H
Eastern Towhee	0.34	1.11	0.47	0.43	H
Willow Flycatcher	0.23	0.63	0.48	0.34	H
American Crow	0.17	0.46	0.66	0.25	H
Brown Thrasher	0.25	0.57	0.4	0.2	H
Northern Mockingbird	0.2	0.66	0.48	0.16	H
Black-capped Chickadee	0.2	0.52	0.35	0.11	H
Northern Cardinal	0.15	0.32	0.34	0.09	H
Yellow-rumped Warbler	0.17	0.46	0.16	0.04	H
Tree Swallow	0.38	1.66	0.81	1.45	S
Yellow Warbler	0.38	1.25	0.52	1.28	S
Bobolink	0.32	1.09	0.87	1.18	S
Gray Catbird	0.35	1.06	0.44	1.09	S
Common Grackle	0.26	0.69	0.86	0.75	S
Snowy Egret	0.14	0.69	0.34	0.73	S
Song Sparrow	0.22	0.54	0.61	0.6	S
Lesser Yellowlegs	0.09	0.51	0.32	0.48	S
Common Tern	0.15	0.45	0.64	0.38	S
Red-winged Blackbird	0.52	1.95	0.86	2.29	L
Double-crested Cormorant	0.11	0.22	0.16	0.61	L
Killdeer	0.05	0.11	0.14	0.56	L
Greater Yellowlegs	0.02	0.02	0.22	0.56	L
Great Egret	0.08	0.15	0.17	0.55	L
Herring Gull	0.08	0.2	0.16	0.55	L
European Starling	0.06	0.2	0.76	0.52	L
Brown-headed Cowbird	0.05	0.06	0.31	0.45	L
American Redstart	0.02	0.02	0.37	0.42	L
Least Sandpiper	0	0	0.37	0.42	L
Canada Goose	0.03	0.05	0.28	0.39	L
Savannah Sparrow	0.05	0.06	0.13	0.3	L

Relative abundance is a comparison of 2006 abundance to average of all survey years (1994-2006). "H" represents higher abundance; "S" represents similar abundance, and "L" represents lower abundance.

With assistance from the Endangered Species biologist from Concord field office, we searched on three separate days for signs of cottontail through the Refuge and Sandy Point, and collect six pellet samples in thick shrub habitat. Even though Parker River has extensive suitable New England cottontail habitat, all pellets were determined to be eastern cottontail. Based on surveys on the Refuge and region-wide survey results (no extant New England cottontail population is known from northeast Massachusetts), New England cottontail is not likely to be present on the Refuge. However, the Refuge would be a good candidate as a reintroduction site due to its relative isolation from the mainland and its naturally sustaining shrub habitats.

Herbivore Management

With the stable high water in the North Pool, beavers have established a lodge in the impoundment, and have been cutting trees (mainly yellow birch) in Hellcat swamp. Routine monitoring of beaver activity is needed to ensure that damage to Maritime forest habitat does not exceed acceptable levels.

Proposal Year: Management Strategy Prescription

- Continue to partner with Massachusetts Audubon Society to monitor landbird use of maritime shrub and forest habitat during spring and fall migration through the banding program.

- Continue the annual one-day deer hunt program to maintain a sustainable deer population. Discontinue the Refuge check station as insufficient numbers of deer are harvested to obtain Refuge-specific biological data.

- Monitor beaver activity for excessive tree felling and girdling. If negative impact on shrub habitat is determined to be excessive, remove problem beaver through trapping.

- Control invasive plants through cutting, girdling, pulling, herbicide application targeting at eradication of certain early detection species (e.g. black locust, rusty willow, autumn olive, multiflora rose), and restoring areas of low invasion.
    - Continue to monitor treated sites (pepperweed, multiflora rose, black locust) to evaluate long-term effectiveness of control.

C. Exemplary Plant Communities

Habitat Objective

Maintain the native plant diversity, physiographic characteristics, and natural functions of the refuge's exemplary plant communities -- interdunal swale, sandplain grassland, and pitch pine dune woodland.

2006 Management Prescription

Pitch Pine Restoration

We completed mapping of all pine forests throughout the refuge, and GPS'ed 10 acres of native pitch pine and 28 acres of black pine forests on the Refuge. We initiated the Pitch

Pine Dune Woodland Restoration Project in 2006 by removing black pines from three areas totaling 7 acres, and planting pitch pine in one of the sites. To date, we've removed about 150 black pine saplings (up to 6 feet) and 100 mature black pine trees. Twenty five 4-6 foot saplings and 50 seedlings were planted in a 5-acre area cleared of mature pines. In September, we treated the incoming invasive undergrowth (black locust, glossy buckthorn, Morrow's honeysuckle) with a 5% Garlon solution.

Monitoring and Surveys

Frog call surveys were conducted on April 2nd, May 4th , and May 16th to monitor singing anuran populations.

Habitat Response

N/A

Response of the Resources of Concern

Monitoring and Surveys

Relative abundance and frequency of occurrence of spring peepers decreased compared to previous year (Figure 2), while American toad and spadefoot toad population have dramatically increased since 1999. The heavy spring rains in 2006 created ideal breeding conditions for eastern spadefoot toads, which are explosive breeders. During the third survey on May 16, we received 18 inches of rain in 6 days, which created numerous "vernal pools" throughout the dune area. Eastern spadefoots were heard at every survey stop; and were heard vocalizing in broad day light. For the second year in a row, we did not detect any wood frogs during the survey; however, two new species, green frog and Fowler's toad was detected in 2006.

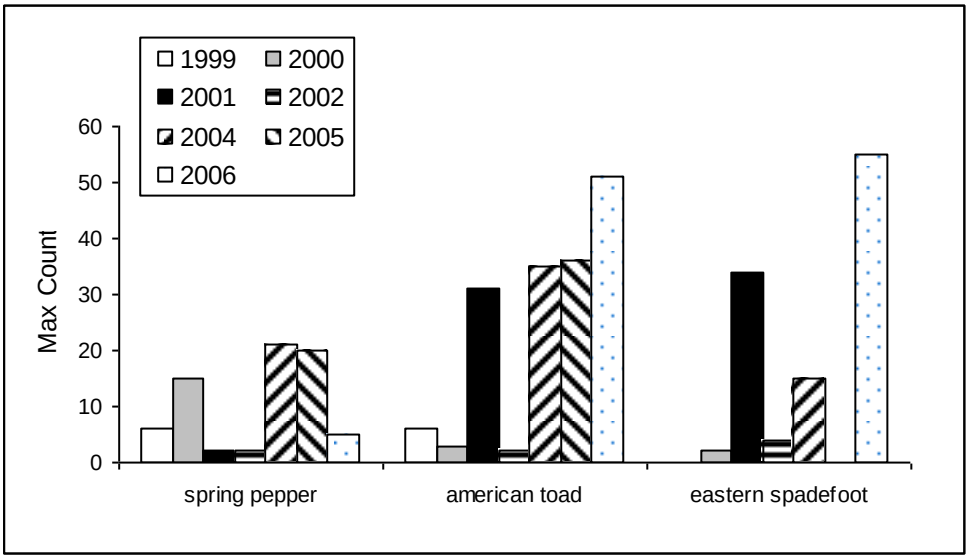

Figure 2. Anuran abundance at Parker River Refuge from 1999 to 2006. Max count is the total number of individuals within a species detected during one survey night. For the purposes of calculating abundance, chorus (where individuals cannot be distinguished) were assigned a value of 5.

Proposal Year: Management Strategy Prescription

- Continue frog-call surveys in spring, timing surveys to major rain events or significant warming periods.
- Restore 5 acres of black pine forest to pitch pine dune woodlands.
  - Selectively cut black pines using chainsaw or heavy equipment (e.g. Geoboy), leaving select mature pines to provide shelter for seedlings.
  - Plant pitch pine seedlings and saplings (up to 5 feet), spaced 15 to 20 feet apart during spring (April to June). Plants should be obtained from a local source if possible; check commercially available plants to ensure that parent stock are obtained from coastal Massachusetts, New England, or New Jersey. Water seedlings and saplings as needed for the first two months.
  - Monitor restoration sites for invasive plants and treat with backpack sprayer as needed.
- Treat Phragmites in Lot 2 swale through cut-stem and drop method, and monitor Galerucella beetles population in swales; augmenting population as needed.
- Start effort to delineate (GPS) the boundary of rare communities.

D. Salt Marsh

Habitat Objective

Annually, manage 2,660 acres of salt marsh, including a mix of high and low salt marsh vegetation comprised of less than 5% overall cover of invasive plants, and pool and panne habitat consistent with local reference sites, to ensure that the quality and natural function of the marsh are sustained and provide breeding habitat for Nelson's and saltmarsh sharp-tailed sparrows, and seaside sparrow, wintering areas for American black duck, and foraging areas for marsh and wading birds and migrating shorebirds.

2006 Management Prescription

<u>Regional OMWM Study</u>

Since 2000, the Refuge has been participating in the Region 5 OMWM Study, whose objective is to determine how the various OMWM techniques are benefiting or impacting resources of concern (birds, vegetation, hydrology, fish, and mosquitoes). Through a partnership with Northeast Massachusetts Mosquito Control and Wetland Management District, we have completed OMWM on approximately 100 acres of salt marsh habitat to date. Influence of the OMWM project extends beyond the actual acres completed. 2006 is the final year of the regional long-term study on OMWM.

<u>Mercury Bioaccumulation Study</u>

Since 2004, Parker River has been participating in a multi-refuge, long-term salt marsh sparrow mercury bioaccumulation study. In 2006, we wanted to determine if the consistently high Hg levels are negatively impact salt marsh sparrow reproductive success at Parker River. Our aim was to collect blood samples from 15 nesting females and corresponding composite nestling samples. Due to the high nest failure (see Resources of Concern section), we were only able to collect blood samples from 12

nesting females and 11 composite nestlings (one was flooded before samples can be taken from nestlings). We also collected 22 unviable eggs for contaminant analysis.

In addition to studying impact of mercury on reproductive success, we also conducted three days of sparrow trapping at three sites located throughout Plum Island Sound in order to better locate the source of mercury contamination. We caught and sampled thirty-seven salt marsh sharp-tailed sparrows during this effort.

Monitoring and Surveys

Surveys conducted in the salt marsh include the salt marsh sparrow survey and the colonial nesting bird survey (coordinated by the State). The salt marsh sparrow survey was conducted in late June/early July of 2006. The colonial nesting bird survey was conducted on June 14th.

Invasive Plant Control

Since 2004, the Refuge has been implementing Japanese knotweed control off-Refuge land in an attempt to eradicate the invasive plant from Plum Island. In 2006, we also initiated a community perennial pepperweed control project, with funds from the National Fish and Wildlife Foundation, Challenge Cost Share program, and the LMRD program.

Habitat Response

Regional OMWM Study

Vegetation and hydrology are being monitored as part of the ongoing regional study. In 2006, data was collected at sites Control, B1 and B2. The data for 2006 will be analyzed by the University of Rhode Island, and a final report for the six-year study will be completed within the next year.

Invasive Plant Control

For the knotweed project, we treated (cut stem and drop and cut and foliar spray) approximately 3.5 acres of knotweed stands along the Plum Island Turnpike. Volunteers contributed more than 360 hours to the knotweed project, and removed roughly 20,000 pounds of knotweed for offsite disposal (drying and burning). We also conducted follow-up monitoring of various treatment methods implemented in 2005. The effectiveness of various treatment methods tested in 2005 and 2006 are summarized below and in Table 3.

Mechanical treatments (Digging or cutting once): We manually cut knotweed at two sites and dug up knotweed at one site in 2005. In 2006, knotweed at all mechanical treated sites came back with no noticeable difference in knotweed vigor, abundance, and size. If anything, all three stands appear to have increased vigor.

Stem Injection involves directly injecting 5 ml of 50-100% Aquamaster between the 1st and 2nd node, and proved to the most effective method, with over 90% second year success on a well established monotypic stand. However, this method is very labor and herbicide intensive. Over 40 staff hours was needed to inject a 6,534 square foot

infestation. The label instructions recommended injecting with 100% Aquamaster. We diluted to 50% herbicide, which proved to be as effective. Even at the reduced concentration, we could not treat the entire stand without exceeding the maximum application rate on the label.

Cut Stem and Drop involves cutting the stems between the first and second node during growing season (June-August) and applying 25% glyphosate in the cut stem within hours. This method is relatively labor intensive, requiring 160 volunteer hours for a stand roughly 1/3 an acre, and 6 staff hours to apply herbicides. The advantage of this method is that it makes use of volunteer hours, and serves to educate landowners and the public about this species. Roughly 50% of the plants treated with this method exhibited re-sprouting later in the season. Monitoring in 2007 will determine second-year effectiveness.

Cut Stem and Foliar Spray involves cutting the knotweed in mid June and then spraying the new growth when it's roughly a half meter in height. To cut the initial stand took 200 volunteer hours, and the foliar application took 8 staff hours. Plants treated with this method did not show any resprouting in late summer. Monitoring in 2007 will determine second year effectiveness.

Table 3. Effectiveness and cost of various control methods for Japanese knotweed.

Treatment Method	Treatment Effectiveness	Labor per Acre		Herbicide Use (Gallons per Acre)
		Volunteer Hours	Staff Hours	
Stem Injection	90% second year	--	267	13.5[1]
Cut and drop[3]	50% damaged	230	18	4.5[2]
Cut and foliar spray[3]	100% damaged	230	9	0.85
Mechanical Only	0% second yr	250	0	--

[1] We used 2 gallons (the maximum application rate for acre) on 0.15 acres.
[2] We used 0.75 gallons on 0.16 acres.
[3] Effectiveness for cut and drop and cut and foliar spray need to be evaluated in 2007 for second year success.

For the pepperweed project, we mapped all pepperweed within a mile of the Refuge and controlled 55 sites on and off Refuge land. Fifteen sites on the Refuge were sprayed with 0.03% Escort solution, and 69 volunteers donated over 200 hours to pull over 3,000 pounds of pepperweed at the other sites. Previous experiments have shown Escort to be 95-99% effective in controlling pepperweed (See Appendix A). Of the 40 sites pulled by hand in June and August, we observed pepperweed growth at only a handful of sites in subsequent (September) visits. Monitoring of these sites will be continued in 2007 to determine long term effectiveness.

For detailed information on these two community invasive management programs, see the respective 2006 Annual Reports.

Response of Resources of Concern

Regional OMWM Study

Macroinvertebrate use, bird use, and mosquito breeding data are being monitored as part of the ongoing regional study. In 2006, data was collected at sites Control, B1 and B2. The data for 2006 will be analyzed by the University of Rhode Island, and a final report for the six-year study will be completed within the next year.

Mercury Bioaccumulation Study

As part of the mercury study, we monitored the reproductive success of salt marsh sharp-tail sparrows. With help from BRI, Rachel Carson, and Concord Field Office staff, Refuge staff and volunteers conducted more than 200 hours of nest searches and found 25 viable nests. Because of the cryptic nature of the sparrow nests and the high probability of non-detection, we used Mayfield's (1975) method for estimating nest success. We also divided the nests into cohort groups (nests that initiated incubation at roughly the same time) as tidal cycles greatly affect nesting success. The table below summarizes the probability of nesting success.

Table 4. Nest success of sharp-tailed salt marsh sparrows nesting at Parker River salt marsh.

	Nest with Eggs	Nests Hatched	Nests Fledged	Egg survival Rate	Hatching Rate	Chick Survival Rate	Overall Survival Rate	Incubation Initiation Date
Tide Cycle 1: June 13 to July 11 (29 days); Flood July 12								
Group A	7 (18)	2(5)	2(5)	0.66	0.42	1	0.27	June 13
Group B	6 (22)	5(13)	5(13)	0.84	0.62	1[a]	0.52	June 19
Group C	2 (8)	1(1)	0	0.13	0.25	--	0	July 2
Tide Cycle 2: July 13 to August 9 (28 days); Flood August 9								
Group D[b]	2(6)	2(6)	2(6)	1.0	1.0	1.0	1.0	July 20
Group E[b]	5(11)	4(10)	0	0.91	0.91	0	0	July 22
Overall	**17(61)**	**14(34)**	**9(24)**	**0.8182**	**0.532**	**0.531**	**0.22**	

[a] Nests were not checked until 11 days after hatching in Group B. Survival rate is presumed to be 1 no flooding occurred between Day 1 and Day 8, when chicks become independent.
[b] All nests in the second tide cycle (Group D and E) were re-nest, as evident by the two to three-egg nests.

The estimated probability of nesting success for Parker River sparrow (0.22) is low compared to that of Rachel Carson (0.318), and other salt marsh sites (0.374 to 0.69) in northeast United States. Flooding was the major cause of nest failure. In late May/early June, there were only 15 days between flood tides (May 28 and June 13). Sparrows arriving at Parker River in May likely synchronized to the flood tide on May 28th. Of the nine nests we found, two were flooded out by the 9.9-foot tide on June 13 (eggs found outside nest cup). Flooding of the nest may explain the low hatching rate in Group A compared to other Groups. Five of the nests were likely abandoned soon after the flood. Group C and E initiated incubation too late, and the chicks were flooded out prior to independence.

BRI is currently analyzing egg and blood samples collected in 2006; and the results will direct research focus for the 2007 field season.

Twenty nesting boxes were installed as part of the mercury study in 2005. Tree swallows nested in 14 of the 19 nest boxes available in 2006. Nesting was initiated in three more boxes, but were abandoned prior to egg laying. The 14 pairs of tree swallows laid 71 eggs, hatched 61 chicks, and fledged 57 young, for a productivity of 4.1 per pair.

Monitoring and Surveys

For a fourth year in a row, the number of sharp-tailed saltmarsh sparrows detected during the annual breeding surveys continues to be high (Figure 3). Preliminary comparisons of Refuge breeding data compared to other sites in Great Marsh suggest higher populations at Refuge sites (Buchsbaum 2006, pers. comm). Detailed comparison of Refuge and other nearby sparrow populations is ongoing.

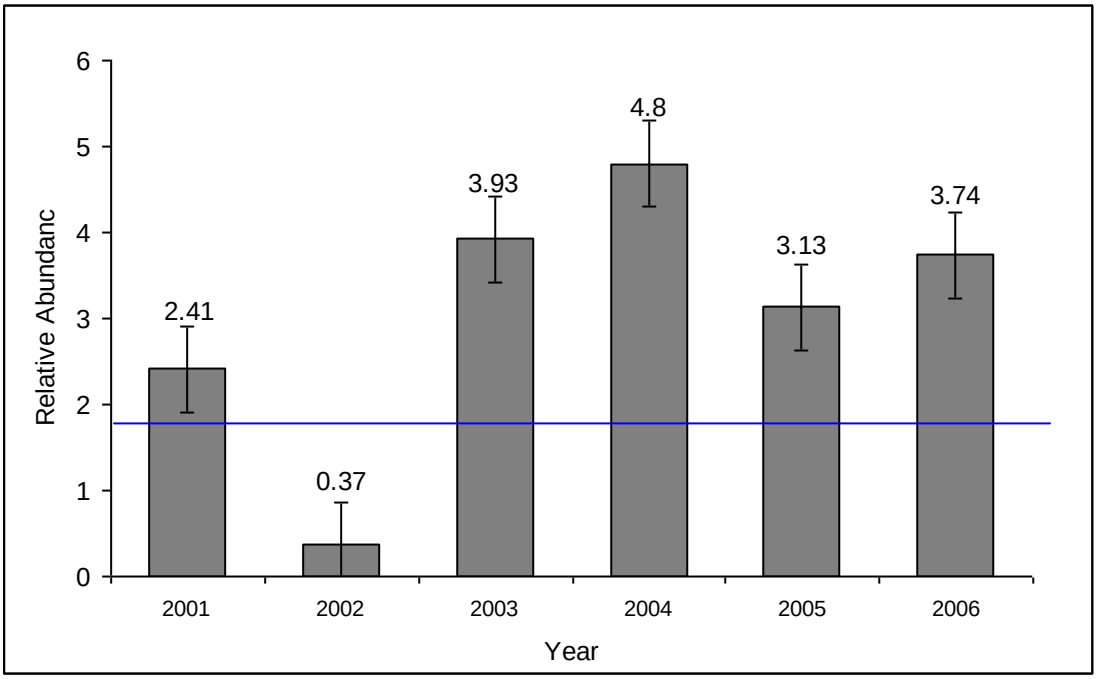

Figure 3. Relative abundance of sharp-tailed saltmarsh sparrow in call-back surveys, calculated as total number of individuals divided by total survey points. Three surveys were conducted for 2001 and 2002 breeding season. From 2003 to 2006, only one survey was conducted per year. Line represents average abundance for all survey years (1994-2006).

The breeding common tern population in Plum Island Sound salt marshes was down compared to previous years. The colony at Woodbridge Island was particularly low at 42 pairs. The landowners at Woodbridge mentioned that there were two distinct colonies on the Island. We only observed one colony during the count. It is likely that the second colony may have been abandoned prior to the count.

Table 5. Common tern breeding pairs observed nesting in Plum Island salt marshes during the State count window (mid June) from 2002 to 2006.

Year	Woodbridge	Plum Island Sound Marshes	Total
2006	42	31	**73**
2005	80	21	**101**
2004	96	26	**122**
2003	75	24	**99**
2002	80	24	**104**

Proposed Year: Management Strategy Prescriptions

- We will increase survey effort for salt marsh sparrow breeding survey in 2007, and conduct two to three surveys corresponding to the start of each nesting cycle.

- Continue to participate in the ongoing mercury bio-accumulation study in salt marsh sparrow, and seek additional funding to expand research to investigate the geographic and biological (species) scope of mercury and other contaminants (e.g. PCBs, organophosphates).
    - Monitor the reproductive success of salt marsh sparrows
    - Investigate trophic pathway of mercury levels in the salt marsh system.

- Continue to control invasive plant species (*Phragmites*, perennial pepperweed, Japanese knotweed) in the salt marsh through cutting, hand pulling, stem injection, and herbicide application (cut and drop or spot treatment).
    - Continue off-Refuge Japanese knotweed control and treat all stands on Plum Island and along the turnpike.
    - Expand perennial pepperweed control through the Great Marsh and work with partners to initiate control in New Hampshire.

- Work with Manomet Bird Observatory and USGS to determine suitability of establishing a Program for Regional and International Shorebird Monitoring (PRISM) site on the Refuge.

- Continue to annually monitor common tern nesting colonies in Plum Island Sound as part of the State's annual colonial nesting bird surveys. As funding allow, increase monitoring of colonies to assess nesting success.

E Grassland and Early Successional Habitats

Habitat Objective

Manage 80 to 130 acres of grassland habitat with minimum size of 20 acres at a height of 8 to12 inches during the summer to provide nesting habitat for grassland nesting birds, such as bobolink and northern harrier, and migration habitat for Lepidoptera, whimbrels, and other species. In addition:

- By 2012, restore 20-50 acres of open fields to a sandplain grassland community, comprised of 80 percent graminoids (little blue stem, coastal switch grass, woodland sedge, Green's rush, poverty grass), 10 percent forbs (stiff aster, seaside goldenrod), and >5 percent bare ground.

- By 2021, maintain a minimum of 50 acres of grassland habitat dominated by grasses (>70%), comprising less than 15 percent shrub species and greater than 5 percent bare ground.

- Maintain 20-30 acres "old-field" that includes less than 40 % shrubs, and over 50% grasses and forbs.

2006 Management Prescription

Grassland and Early Successional Habitat Management

The Refuge has maintained 130 acres of grasslands through annual mowing to provide breeding and migratory habitat for grassland dependent species such as the Northern Bobolink, Savannah Sparrow, Meadowlarks and several species of raptors including Short-eared owls and Northern Harriers. The open field habitat include: the North Pool Field, south portion of the Bill Forward Field, Cross-Farm Hill, Stage Island Field, and Nelson's Island. In 2006, we mowed the open fields in early September. The north portion of Bill Forward Field is maintained as early successional shrub habitat, and is mowed on a 3-5 year cycle. No management was conducted in this shrub habitat in 2006.

Artificial Nesting Structures

The Refuge maintains artificial nesting structures for two species, purple martin and ospreys, that have largely lost their natural breeding habitat. Purple martin colonies are located at three sites throughout the Refuge: at the old Refuge HQ located on the north end of Plum Island, the new HQ site, and the visitor contact station near lot #1. Osprey platforms are located at three sites throughout the Refuge: the end of the Pines Trail road in the salt marsh, on the south side of Cross Farm hill and at Nelson's Island.

Invasive Plant Management

In 2006, we spot treated small stands of spotted knapweed (totaling 0.15 acres) in grassland habitats throughout the Refuge with 1.5% Garlon.

Habitat Response

Grassland Management

Over the years, the staff has noticed the plant composition in the fields to shift from graminoid-dominated species to woody and invasive species. In 2006, we conducted an assessment of several grassland units to determine existing plant compositions and site capability. Below is a summary of the assessment conducted by Botanist Joanne Hoy.

SUB-HEADQUARTERS FIELD
The sub-headquarters field is dominated native graminoid and herbaceous vegetation (including *Aristida tuberculosa*) and is largely uninvaded. The soil upslope from the artificial pools appears to be sand, and has potential to be managed as a grassland unit. Mowers should leave a buffer around the sand dune area.

NORTH POOL FIELD
Most of the North Pool field is patches of coastal interdune swales (including cranberry bogs) and maritime shrublands. Native roses and other woody plants are increasingly dominating the field. The drier portions are dominated by nonnative grasses. The number of invasive plants increases from north to south.

If left unmanaged, the drier patches would likely fill in with tall shrubs and become more or less like the shrublands on the east side of the main road. The wet patches might be more productive for the large cranberry *(Vaccinium macrocarpon*), woolly bulrush *(Scirpus cyperinus*), three-square rush *(Schoenoplectus pungens*), and other freshwater wetland plants if the field were not mowed.

BILL FORWARD SHRUBLAND
The Bill Forward shrubland is a mosaic of grassy openings and shrubs. The area south of the bird blind is about 50% shrubs, with 25% more that has small shrubs interspersed with graminoids, held in check by mowing every three to five years. The area north of bird blind has fewer shrubs (20% cover), more graminoids, and greater relief. The small native trees are providing habitat for establishment of exotic and invasive plants, as is the black pine forests on either side of the blind.

This unit has the best potential to be manages as a native grassland habitat. Encouraging native grasses here might require management that mimics poor farming practices, such as frequent mowing and removal of vegetation or late-spring mowing or burning to encourage little bluestem.

BILL FORWARD FIELD
The drier areas of the Bill Forward field (near the road) are dominated by a mix of native and non-native graminoid and herbaceous species. Wet areas are dominated by monotypic stands of curly dock *(Rumex crispus*), foxtail barley *(Hordeum jubatum*), and common plantain *(Plantago major*), probably from historic plantings. The dominant soil in the Bill Forward Field is sand, not Ipswich/Westbrook mucky peat as mapped by National Soil Conservation Service (Hoy 2006). If it once was muck, the organic material has been incorporated into the darker fine sand of the top 30 centimeters of soil. Without active management, this field may revert to marsh, grading to shrubs in the higher areas.

CROSS FARM HILL
The upper part of Cross Farm Hill is covered with a rather uniform mix of mainly non-native grasses and forbes. Invasive species, such as Aistic bittersweet, Canada thistle, wild garlic are prevalent and dense in spots. A small patch of black swallowwort (*Cynanchum louiseae)* was also noted in the field.

This unit would most likely become coastal forest/woodland if left alone; typically, this soil type supports woods dominated by oaks, hickory, red maple, sugar maple, birches, and white pine. Presently it has virtually no native plants other than poison ivy, milkweed and goldenrods (Solidago spp).

STAGE ISLAND FIELD

Stage Island is dominated by a mix of mostly non-native grasses and forbes. Canada bluegrass is the most widespread invasive. There are large populations of leafy spurge, Asian bittersweet, and drooping brome grass, distributed in localized patches. Purple loosestrife is found in the lower areas.

The soil is Windsor loamy sand, and naturally supports oaks, pines, gray birch, poplar, red maple, and sugar maple (USDA-NRCS 2004). If unmanaged, it would likely revert to coastal forest/woodland with slow-growing shrubs in the understory.

Invasive Plant Control

In 2005, sprayed several dense infestation of spotted knapweed at Stage Island Field with 1.5% Garlon and hand-pulled other smaller infestations along the impoundment dikes. Knapweed re-sprouted from the area that was hand-pulled. In the area treated at Stage Island, there is little or no knapweed and other graminoid and herbaceous species have established in the treated area (see Appendix A for before and after photos).

Response of Resources of Concern

Artificial Nesting Structures

The total nest count for the purple martin was down on the Refuge in 2006; however, the hatching rate (74%) and the fledgling rate (100%) were significantly higher compared to 2004 and 2005. Mid-July of both 2004 and 2005 had several days of rain and cold temperatures. Such conditions, at a time when most nestlings were a week to ten days old, probably contributed to the low fledgling rate. In 2006, heavy rainfall occurred in May when purple martins were returning to the breeding sites and establishing nest; attributing to the lower nesting attempts.

Two of the three osprey platforms were used during the 2006 season. The pair at Nelson's Island successfully fledged two young. Two chicks hatched at the Pines Trail platform, and failed to fledge. No pairs nested at the platform at Cross Farm, installed in fall of 2005; however, an osprey was observed building the nest in late summer.

Table 6. Productivity results from three seasons of monitoring at Purple Martin colonies. Note: the nesting structures at sub-HQ were not installed in 2006 due to its history of being unoccupied.

	2004	**2005**	**2006**
nests with eggs	45	38	21
total # of eggs (E)	225	179	96
# of eggs that hatched (H)	163	101	71
% of eggs that hatched (H/E)	72	56	74
total # of young fledged (F)	61	50	71
% of young that fledged (F/H)	37	50	100
overall success rate (F/E)	27	28	74

Proposal Year: Management Strategy Prescriptions

- Mow grassland units after bird breeding season (August 31). In the sub-HQ field, leave the sandy dune area unmowed.
- Let southern third of the North Pool Field revert to open shrub habitat. Monitor shrub regeneration and control invasive species (glossy buckthorn and morrow's honeysuckle) to ensure a native dominated vegetative community
- Map and treat black swallowwort at Cross Farm; and continue spotted knapweed control
- Install purple martin boxes at old HQ, new HQ, and Lot 1 in early April, and continue to monitor purple martin productivity using volunteers.
- Recruit volunteers to conduct breeding bird surveys in grassland units.

F. Impoundment Management

Habitat Objective
Annually manage the three brackish impoundments (totally 262 acres) to support spring and fall migrating shorebirds, spring and fall migrating waterfowl (American black duck), and breeding marsh and wading birds. Management prescription will change from year to year, dependent on wetland dynamics and vegetative composition, but will be directed to provide the following each year:

1. Migrating shorebirds: shallow (<10 inches water depth) to mudflat habitat with sparse (<15% cover) to no vegetation, at time of peak migration (late May and early August)/
2. Fall migrating waterfowl: shallow flooded (<12 inches) annual vegetation composed primarily of *Cyperus*, *Echinochloa*, *Polygonum*, *Bidens* and other seed producing moist soil vegetation at time of peak migration (late October to early November)
3. Manage for breeding wading birds (e.g. clapper rail, American bittern, king rail, least bitter, marsh wren, sora) and waterfowl (e.g. black duck, green-winged teal, gadwall) by maintaining water levels and controlling invasive plants.

Management Prescription in 2006

<u>North Pool</u>
No management was conducted in the North Pool for 2006. However, in an attempt to draw down Bill Forward Pool during spring shorebird migration, the Water Control Structure in the North Pool was opened on June 15 to prevent overflow of water into the BFP. The WCS was accidentally left open over the weekend, and the water level in the North Pool dropped roughly three feet during this incident. Water was pumped from the BFP to the NP subsequently to reflood the North Pool for the remainder of the breeding season. Call back surveys were conducted five times in the North Pool to monitor for breeding marsh and wading birds.

<u>Regional Shorebird Impoundment Study</u>
Bill Forward and Stage Island Pools participated in Year 2 of the R3/5 Impoundment Study. Bill Forward Pool received spring draw down for 2006. The objective was to expose the maximum mud flat and shallow water (< 10 inches) during peak spring

shorebird migration (May 25). We started the draw down of the Bill Forward Pool (using pump) on May 1. Due to heavy rain events in May and early June, we were not able to draw down the Bill Forward Pool for the shorebird migration. Water levels were drawn down starting late June for the fall shorebird migration, with a low water reading of 1.5 feet on July 28. Re-flooding occurred naturally from precipitation (Figure 4). The impoundment froze on December 11.

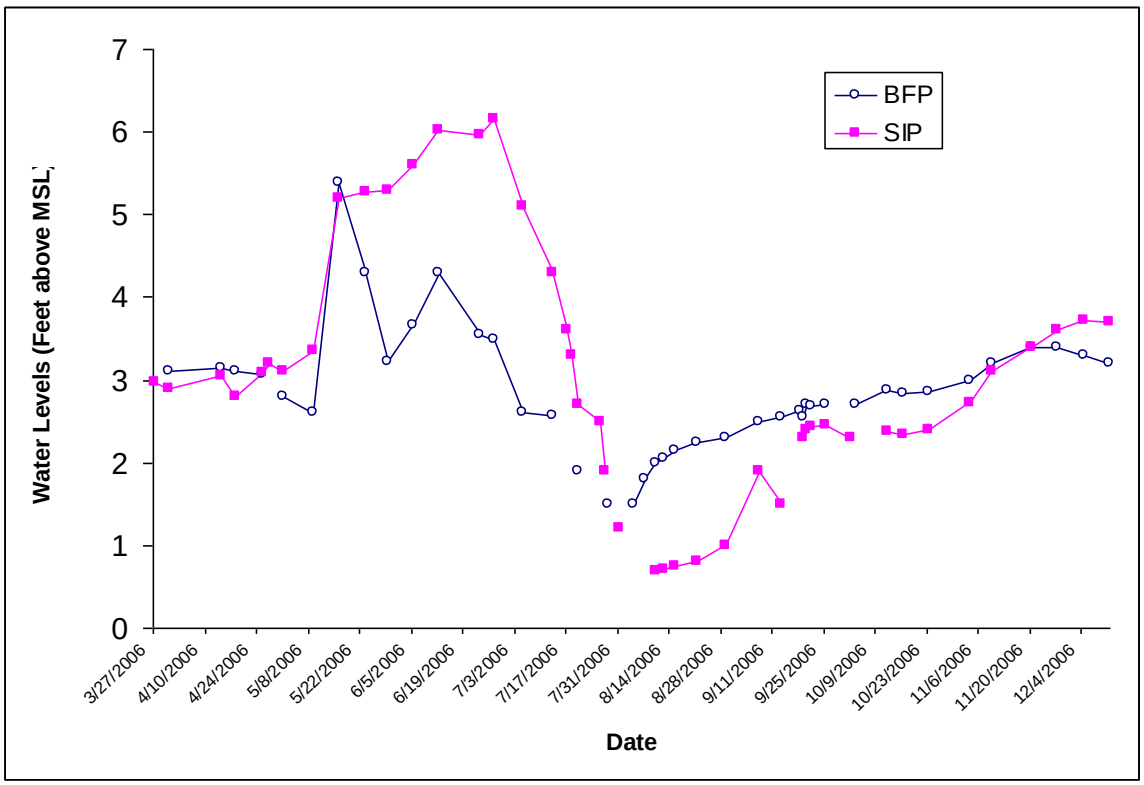

Figure 4. Water levels in the Bill Forward and Stage Island Impoundments through the 2006 field season. We were not able to achieve optimal water levels in the Bill Forward Pool for the spring shorebird migration (late April to mid June) due to heavy rainfall in May.

Stage Island Pool received the fall draw down for 2006. The objective was to provide waterfowl foraging during the spring migration and expose maximum mudflat and shallow water during peak spring shorebird migration (August 10). We started draw down in Stage Island on March 27 and flooded up on April 18 for the spring waterfowl migration. For the fall shorebird migration, we started draw down on July 3, and flood up on September 1. We maintained the water level between 2.3' and 3.4' for the fall waterfowl migration. The impoundment froze on December 11.

Habitat surveys conducted as part of the impoundment study include two vegetation cover surveys and a species composition survey. The survey area for the Shorebird Impoundment Study is smaller than the impoundment study because some robustly vegetated areas were excluded in order to improve detectactability of birds. For long-term continuity of data, we also conducted vegetation surveys in the entire impoundment per 1994 protocol.

Wildlife surveys conducted as part of the impoundment study includes weekly waterbird surveys and two invertebrate surveys, timed with peak spring and fall shorebird migrations.

Habitat Response

Regional Shorebird Impoundment Study

Within the shorebird impoundment study area, the most frequent plant species found in both impoundments was dwarf spike rush (*Eleocharis parvula*). Other common species found in the Bill Forward Pool include *Pluchea purpurascens, Schoenoplectus maritimus*, and *Scirpus* spp. In the Stage Island Pool, *Phragmites australis* was the other dominant species.

Table 7. Common species found in Shorebird Impoundment Study Areas.

Species	Bill Forward		Stage Island	
	Freq	Abun	Freq	Abun
Eleocharis parvula	0.69	40.50	0.19	3.77
Pluchea purpurascens	0.28	6.23	--	--
Schoenoplectus maritimus	0.28	3.73	0.06	0.42
Scirpus validus	0.19	2.44	0.09	1.06
Phragmites australis	0.06	0.42	0.16	6.09
All species	0.75	58.15	0.38	18.26

Vegetation Surveys in Entire Impoundment

Vegetation surveys of the entire impoundments found higher species richness[3] in the Bill Forward Pool in 2006 compared to previous years (Figure 5). Species richness for the Stage Island impoundment remained constant in the past three years. Appendix B includes the complete list of plants found in the impoundments from 2004-2006.

In the Bill Forward Pool, we noticed an increase in fresh to brackish marsh plants, such as *Bidens conata, Chenopodium rubra, Cyperus strigosus, Lythrum salicaria*, and *Pluchea purpurescens* (Figure 6). Conversely, brackish and saline moist soil species, such as *Eleocharis parvula* and *Schoenoplectus spp.* declined compared to previous years. The change in vegetative community may be attributed to the heavy rainfall at the beginning of the growing season, and the fact that flooding of the impoundment occurred mainly through natural inflow (ground water or precipitation) instead of input of salt water through the water control structure. We also observed a general decrease in invasive robust plants (*Phragmites australis*, *Lythrum salicaria*, and *Typha latifolia*) in the Bill Forward Pool from 2004 to 2006 (Figure 7).

The most abundant plants in the Stage Island Pool include *Phragmites australis* (17%), *Panicum dichotolorum* (9%), and *Typha latifolia* (7%). Amount of bare ground doubled from 2005 to 2006 (from Freq of 0.33 and Abun of 16% to Freq of 0.55 and Abun of 34%), suggesting that management practices to reduce robust vegetation is succeeding in

[3] Species Richness shown are Heltshe's Jacknift Estimates based on observed species richness and sample size.

the Stage Island Pool. Frequency and abundance of *Phragmites*, *Typha*, and *Lythrum* did not change from 2004 to 2006.

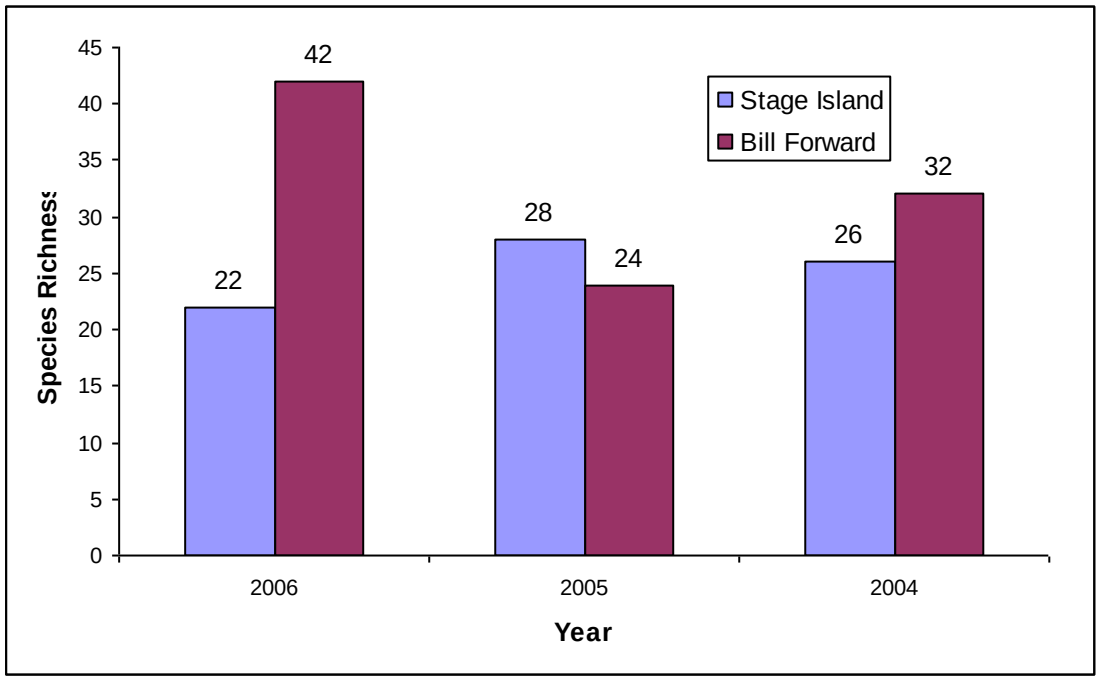

Figure 5. Species richness of the Bill Forward and Stage Island Pools from 2004-2006.

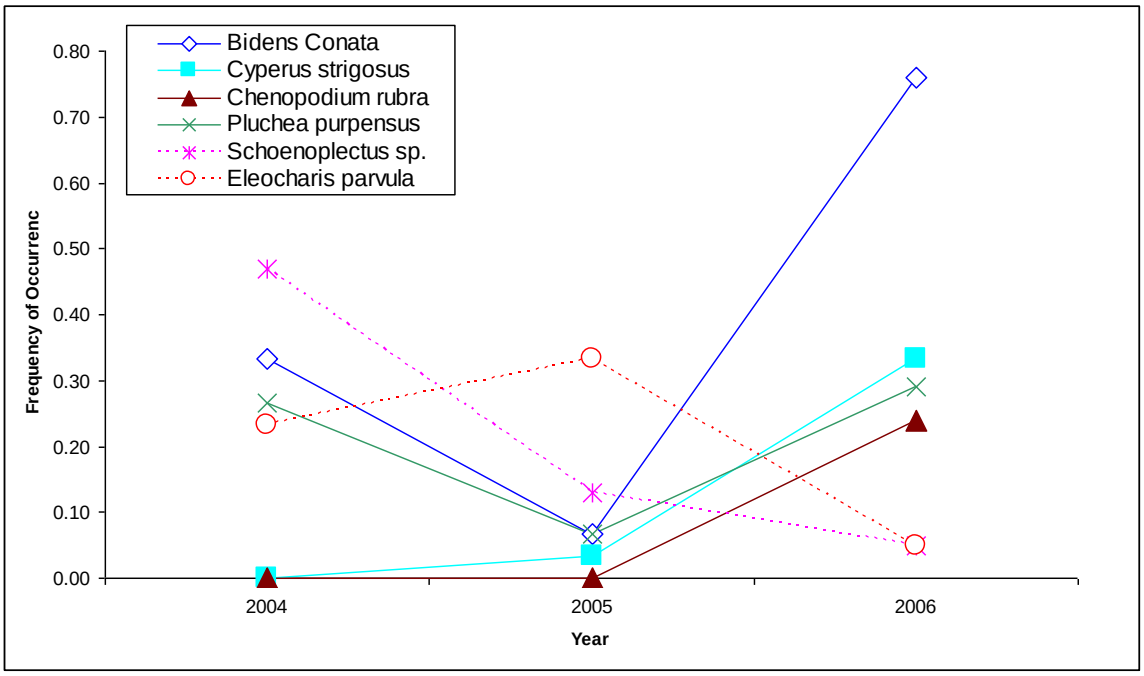

Figure 6. Change in frequency of occurrence of certain plant species in Bill Forward Pool from 2004 to 2006.

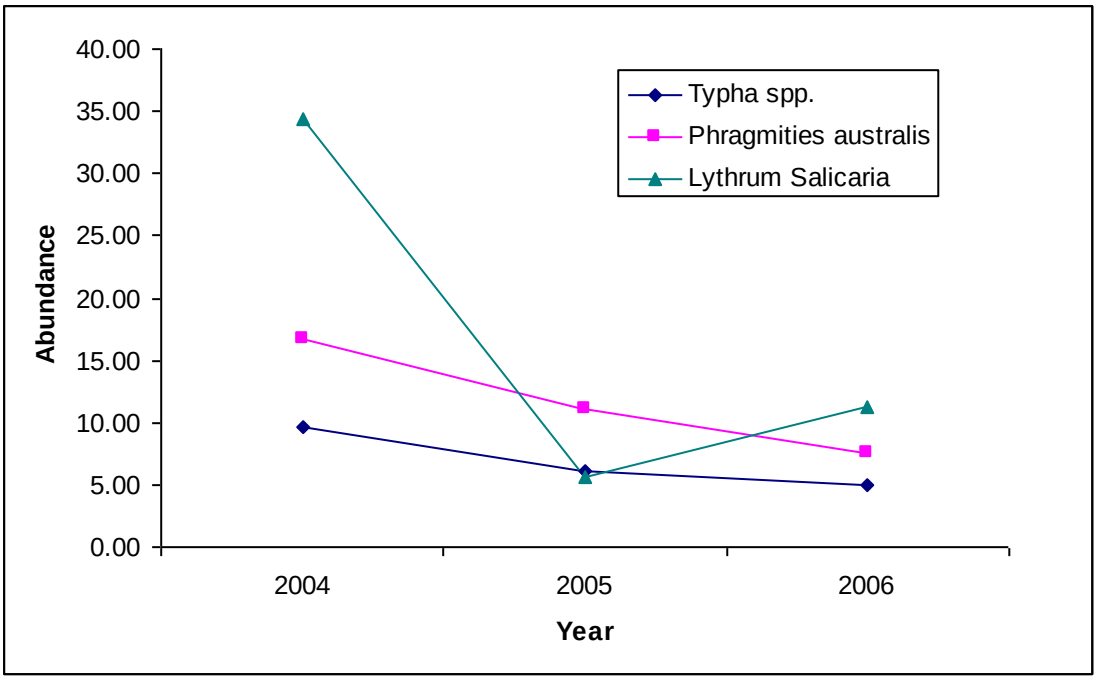

Figure 7. Change in abundance of three robust vegetation in Bill Forward Pool from 2004 to 2006.

Response of Resources of Concern

Monitoring and Surveys

A total of six marsh and wading species were detected during the call-back surveys in the North Pool, the most common species were sora rail, Virginia rails, and common moorhen.

Table 8 Results of marsh and wading birds call-back surveys in the North Pool.

	May 24	June 12	June 21	June 30	July 14	2006 Average	2005 Average
Sora rail	11	6	1	1	2	4.2	5
Virginia rail	17	9	3	7	9	9	4.25
Least bittern	0	3	4	2	5	2.8	1.25
American bittern	1	2	0	0	0	0.6	0.25
Common moorhen	9	8	6	0	0	4.6	1
King rail	1	0	0	0	0	0.2	0.5
American coot	2	0	2	0	0	0.8	0

Regional Shorebird Impoundment Study

Peak waterbird use in both impoundments occurred during the fall shorebird migration (see Appendix C). Maximum bird use in Stage Island Pool, with 1,171 birds, was

recorded on August 4. Maximum bird use in Bill Forward Pool, with 957 birds, was recorded on August 11. These peaks and dates were similar to that of last year.

Shorebirds were by far the most numerous guild using the impoundments. Waterfowl was the second most numerous guild using the impoundments. Peak waterfowl use was recorded in Bill Forward Pool on October 16 (427 dominated by AGWT, NOPI, ABDU), and on November 9 in the Stage Island Pool (1,077 dominated by AGWT, NOPI, ABDU, MALL) (Figure 13). Wading bird use peaked on July 28 in both Bill Forward (39) and Stage Island (25), dominated by snowy egret.

Due to the unusually high rain fall and the inability to draw down the Bill Forward Pool, no impoundment habitat was available for shorebird use during the spring shorebird migration. Peak fall shorebird migration occurred on August 11 (816) in the BFP and on August 4 (1065) in the SIP, both dominated by SESA and SEPL (see Appendix C). Unlike last year, there was no separation between peak adult and juvenile migration for fall shorebirds.

Benthic invertebrate availability and abundance was higher in the Bill Forward Pool in 2006 for both the spring and fall shorebird migration. This differs from 2005 when invertebrate abundance was higher SIP during spring shorebird migration (spring drawdown) and higher in the BFP (fall drawdown) during the fall shorebird migration (Table 8). Even though invertebrate abundance was high in the BFP in 2006, it was not available to shorebirds during peak migration because of unusually high precipitation. The lack of predation in the BFP during the spring migration may explain the higher abundance during the fall migration. The lower invertebrate abundance in the Stage Island Pool in Fall of 2006 may also be attributed to the high water level through the early growing season (5-6' depth) and the rapid drawdown that dried out benthic habitat.

Table 9. Benthic invertebrate abundance in the Bill Forward and Stage Island Pool during spring and fall peak migration for 2005 and 2006.

	2005			2006		
	# Pts	# Invert	Total Mass (mg)	# Pts	# Invert	Total Mass (mg)
BFP, Spring	4	23	15.25	32	2,927	1,050.2
SIP, Spring	29	454	115.58	32	1,280	184.19
BFP, Fall	23	1239	209.0	32	1,180	747.0
SIP, Fall	32	293	92.5	20	90	51.6

Proposal Year: Management Strategy Prescriptions

- Continue to participate in the Regional Impoundment Study, implementing spring drawdown of Bill Forward Pool and fall drawdown of Stage Island Pool during 2007. Continue to monitor waterbird use and response of invertebrates and the vegetative community.

  BFP: *Spring Shorebird, Full Waterfowl Migration Drawdown*
  - Maintain full pool during winter and spring months (until April).

- Starting mid April, drawdown water level during a 6-8 week period such that shallow water (<10 inches) and mudflats are maximized at peak shorebird migration (late May).
- Maintain low water from mid June to mid August to encourage germination of moist-soil plants and growth of invertebrate population.
- Starting mid-August, start slow flooding of impoundment for the late shorebird fall migration and fall waterfowl migration. Maximize optimal water level for dabbling ducks (12-18 inches) in mid September and optimal water level for diving ducks (> 24 inches) in mid October.
- Flood water level to full pool prior to freeze date.

SIP: *Fall Shorebird, Spring and Fall Waterfowl Migration Drawdown*

- Maintain full pool during winter months (until March)
- Starting early March, drawdown water levels during a 2-3 week period to provide spring waterfowl migration habitat. Maintain water levels at an average depth of 12-18 inches for 2-3 weeks, then flood up to full pool by early May.
- Maintain full pool from May until late June.
- Starting late June to early July, drawdown water levels over a 6-8 week period such that shallow water (<10 inches) and mudflats are maximized at peak fall shorebird migration (late July).
  - Maintain low water levels from mid August to early September to encourage germination of moist-soil plants.
  - Starting early September, start slow flooding of impoundment to maximize optimal water level for dabbling ducks (12-18 inches) in later September and diving ducks (>24 inches) in late October.
  - Flood water level to full pool prior to freeze date.

- Install staff gauges in relation to absolute sea level at the North Pool and on the tidal creek side of the water control structures.

- Continue to manage the North Pool to benefit breeding wading birds and waterfowl by maintaining high water levels through the breeding season (April – August). Continue marsh and wading bird breeding survey (4 surveys) in the North Pool.

- Monitor plant response to water level management using established vegetation plots in Bill Forward and Stage Island Pool according to 1994 monitoring protocols.

- Manage the robust vegetation area against invasive plants (i.e. Phragmites, purple loosestrife) and promote a mix of native wetland plants (e.g. cattail, asters, beggars tick).
  - Augment existing Galerucella beetles on the Refuge by releasing additional beetles in the three impoundments and at the new headquarters.

- Using water level manipulation, and if necessary herbicide and mowing, manage against Phragmites and cattail in Stage Island and Bill Forward Pools.

G. Thacher Island

Habitat Objective

By 2015, restore a colony of common and roseate terns to Thacher Island NWR by creating gull-free zones on the Refuge portion of the Island, removing predators, and providing optimal breeding habitat in an area not susceptible to storm surges.

2006 Management Prescriptions

Due to staff shortage in early summer, we were not able to conduct the annual nesting gull count and egg addling; however, Massachusetts Department of Fish and Game was conducting their state-wide 5-year colonial nesting bird census in 2006, and conducted a survey for Thacher Island.

Refuge staff visited Thacher Island in late June to continue plant inventory of the island.

Habitat Response

N/A

Response of Resources of Concern

The State colonial nesting bird census observed the following nest count by species on Thacher Island: 344 greater black-backed gull, 855 herring gull, 2 mallard, 3 Canada goose, and 3 double crested cormorants.

Proposal Year: Management Strategy Prescriptions

- Conduct breeding gull census in late May and addle all eggs found. Conduct follow-up survey in mid June to monitor success of addling efforts.

Appendix A
Photoplots of Invasive Control Treatments

Multiflora Rose Control

Multiflora Rose- Pt 8- Close-up Before Treatment, 6/23/2005

Multiflora Rose- Pt 8- Close-up, After Treatment, 6/23/2005

Perennial Pepperweed Control

Pre-treatment- close up shot, taken in July 2005

Post-treatment-close up shot; taken 1 year after treatment of 0.05% Escort in July 2006

Spotted Knapweed Control

Spotted knapweed in Stage Island Field, Pre-treatment, Photo taken 8/9/2005

Stage Island Post Treatment, Photo taken 7/19/2006

Appendix B
Summary of Vegetation Survey in the Impoundments

Table B-1. Frequency of occurrence and percent abundance of plant species found in the robust vegetation area of the Stage Island Pool from 2004 to 2006

	2006		2005		2004	
Species	Freq.	Abd	Freq.	Abd	Freq.	Abd
Agrostis gigantea ?			0.05	1.86		
Agrostis stolonifera			0.06	4.74	0.08	1.00
Atriplex patula			0.01	0.32	0.01	0.02
Bare	0.55	33.67	0.33	15.80	0.30	21.45
Bidens connata	0.01	0.02	0.08	1.27	0.05	1.52
Calystegia sepium	0.01	0.13	0.01	0.32	0.03	0.20
Chenopodium rubra	0.04	0.80	0.01	0.03		
Cyperus esculentus			0.01	0.14		
Cyperus filicinus			0.02	0.46		
Eleocharis parvula	0.01	0.02	0.02	0.27	0.01	0.02
Erechitites hieracifolia	0.04	0.62	0.13	3.67	0.05	0.12
Frangula alnus			0.02	0.05		
Gallium tinctorium	0.02	0.34	0.03	0.70	0.06	0.62
Hypericum mutilum			0.03	0.49		
Impatiens capensis			0.01	0.14		
Juncus canadensis	0.01	0.04	0.02	0.46	0.02	0.18
Lythrum salicaria	0.08	1.13	0.15	3.40	0.13	3.97
Panicum dichotoflorum	0.27	8.95	0.50	34.35		
Panicum sp.			0.16	6.20	0.01	0.02
Parthenocissus quinquefolia			0.01	0.03		
Phragmites australis	0.45	17.43	0.54	30.41	0.44	13.76
Polygonum sp.	0.03	0.06	0.06	0.92	0.01	0.02
Rumex sp.	0.01	0.13	0.07	1.65	0.04	0.36
Scirpus americanus	0.02	0.34			0.06	0.73
Scirpus maritimus	0.18	4.42	0.15	3.92		
Scirpus pungens			0.03	0.89		
Spartina alterniflora	0.06	1.85				
Spartina pectinata			0.04	2.87	0.04	1.48
Toxidendron radicans	0.01	0.02			0.01	0.15
Typha latifolia	0.25	6.80	0.18	8.91	0.36	8.39
Water	0.28	21.06			0.11	8.55
Wrack	0.02	0.84			0.28	22.65

Table B-2. Frequency of occurrence and percent abundance of plant species found in the Bill Forward Pool from 2004 to 2006

	2006		2005		2004	
Species	**Freq**	**Abun**	**Freq**	**Abun**	**Freq**	**Abun**
Achillea millefolium					0.07	0.17
Agalinus maritima					0.03	0.08
Agrostis stolonifera	0.48	11.14	0.50	30.00	0.67	13.48
Aster subulatus	0.19	3.36				
Aster tenuifolis	0.1	7.07			0.07	0.62
Atriplex patula	0.14	0.48	0.07	0.17	0.07	0.17
Bare Ground	0.24	2.45	0.37	16.27		
Bidens Conata	0.76	19.83	0.07	1.80	0.33	4.10
Calystegia sepium	0.14	0.36	0.17	2.43	0.20	1.85
Carex straminea	0.05	0.12	0.13	1.23		
Chenopodium rubra	0.24	0.48				
Convulvus arvensis	0.05	0.12				
Cyperus filicinus	0.05	0.12				
Cyperus strigosus	0.33	1.45	0.03	0.53		
Dodder					0.07	0.17
Echinochloa sp.	0.1	0.24				
Eleocharis parvula	0.05	4.07	0.33	29.13	0.23	19.30
Epilobium cilatum	0.05	0.74				
Erechtites heiracifolia	0.24	0.6	0.10	1.60	0.33	1.73
Erogostis sp.	0.1	0.86				
Gallium tinctorium	0.48	11.79			0.07	0.62
Hordeum jubatum	0.05	0.12	0.07	1.80		
Juncus canadensis	0.05	0.12	0.03	0.08		
Juncus gerardii			0.07	0.62		
Lycopus americanus	0.1	0.36	0.03	0.08		
Lythrum Salicaria	0.76	19.86	0.43	5.63	0.73	34.35
Panicum dichotoflorum	0.33	11.8	0.10	1.88		
Panicum virgatum					0.07	2.18
Parthenocissus quinquefolia					0.03	0.53
Phragmities australis	0.43	7.5	0.33	11.05	0.50	16.63
Pluchea purpensus	0.29	5.9	0.07	0.17	0.27	1.12
Polygonum spp	0.05	0.73			0.13	0.33
Polygonum punctatum	0.14	1.48				
Rumex sp.	0.05	0.12	0.10	0.70	0.03	0.08
Rumex verticillatus	0.05	0.12				
Schoenoplectus maritimus	0.048	2.5	0.03	0.53	0.17	4.80
Schoenoplectus pungens			0.10	1.88	0.30	6.38
Schoenoplectus sp.	0.05	2.5	0.13	2.41	0.47	11.18
Scirpus acutus	0.14	0.98				
Scirpus validus					0.03	0.08
Solidago sempervirens			0.07	0.17		
Symphyotrichum subulatum					0.10	1.43
Toxicodendron radicans					0.03	2.87
Typha spp.	0.19	5.05	0.17	6.12	0.17	9.63
Water			0.17	13.60	0.27	24.13

Appendix C

Waterbird Use in the Impoundments in 2005 and 2006